Mega-Match

KAY ELECTRIC COMPANY

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B

INSTRUCTION MANUAL

for the

Mega-Match

ISSUE C

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Note: Kay model 100-A ECR works with this unit. (sweep osc only)

KAY ELECTRIC COMPANY

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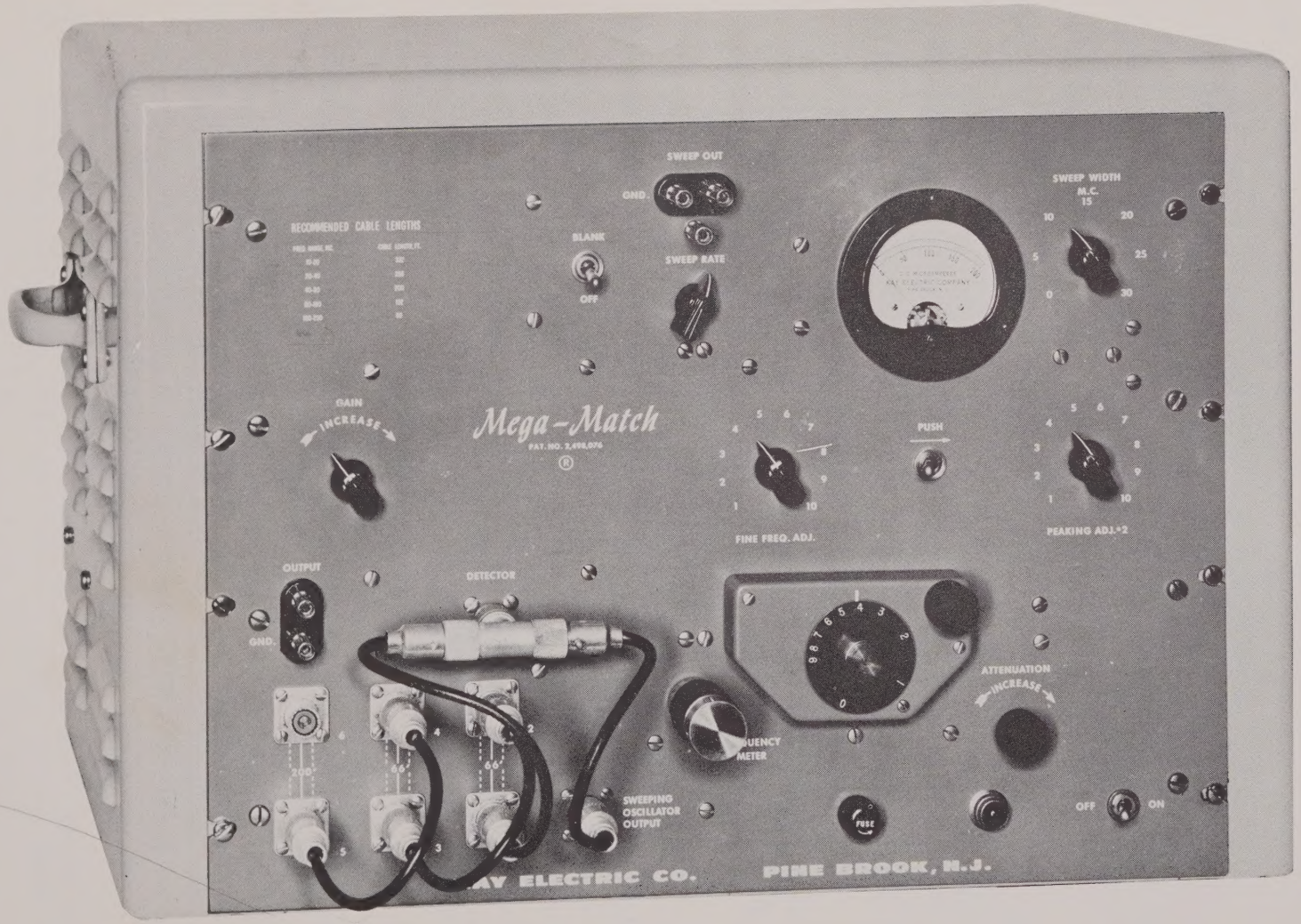


Figure 1, MEGA-MATCH.

SECTION I
INTRODUCTION

A. DESCRIPTION.

The MEGA-MATCH is a swept-frequency reflection coefficient meter designed for use with an oscilloscope in determining the impedance-vs-frequency characteristic of a particular device. It is calibrated over the frequency range of 10 to 900 mc, and usable to 1000 mc. Within its frequency limits, the instrument provides an instantaneous visual display of reflected energy-vs-frequency over frequency sweep widths of up to 30 mc. The MEGA-MATCH includes a "Mega-Sweep" type of sweeping oscillator which may be used independently as a swept-frequency signal source.

B. SPECIFICATIONS.

Frequency Range: calibrated 10 to 900 mc (usable to 1000 mc).

Frequency Measurement: micrometer-controlled wavemeter, accurate to approximately 1 mc.

Sensitivity: Reflection coefficients down to approximately 0.01 up to 500 mc, and 0.1 from 500 to 1000 mc can be seen.

Frequency Resolution: One sine wave of beat note per mc of sweep width at low frequencies, per 2.5 mc at intermediate frequencies, per 5.0 mc at high frequencies.

Sweeping Oscillator:

Frequency Range: 50 kc to 950 mc.

Sweep Width: 50 kc to 40 mc.

Sweep Rate: variable around 60 cps; locks to line frequency.

Sawtooth Voltage: approximately 20 volts amplitude; available for horizontal deflection of oscilloscope trace.

RF Output Impedance: 50 ohms (approx.).

RF Output Voltage: 100 mv (open circuit); 50 mv into nominal 50 ohms.

RF Output Attenuator: uncalibrated microwave attenuator, continuously variable to 26 db. Attenuation characteristic flat over output frequency range.

Output Waveform: less than 5% harmonic distortion at full output. Less than 2% at half output.

Amplitude Modulation: less than 0.1 db/mc over frequency sweep.

Power Requirements: Input approx. 125 watts, 117-volts (±10%), 50-60 cps. B^+ electronically regulated.

Dimensions: 15¼" x 22" x 15½".

Weight: 75 lbs.

Accessories Supplied: Interconnecting patch cords and 60-ft. length 50-ohm cable.

C. PURPOSE.

The primary function of the MEGA-MATCH is to provide a dynamic evaluation of mismatch to a transmission line. It provides an oscilloscope presentation which continuously displays any variations in transmission line reflection coefficient brought about, over a wide band of frequencies, by adjustment of such devices as broad-band antennas, input circuits of broad-band amplifiers, matching transformers, transmission line terminating impedances, etc.

It also provides data from which standing-wave ratios and absolute values of impedance may be deduced. It further permits the measurement of both amplitude and phase angle of the reflection coefficient at a particular frequency. With this information and the aid of a Smith Chart (Figure 4), the resistive and reactive components of the impedance at that frequency may be determined. (See Applications, Section IV.)

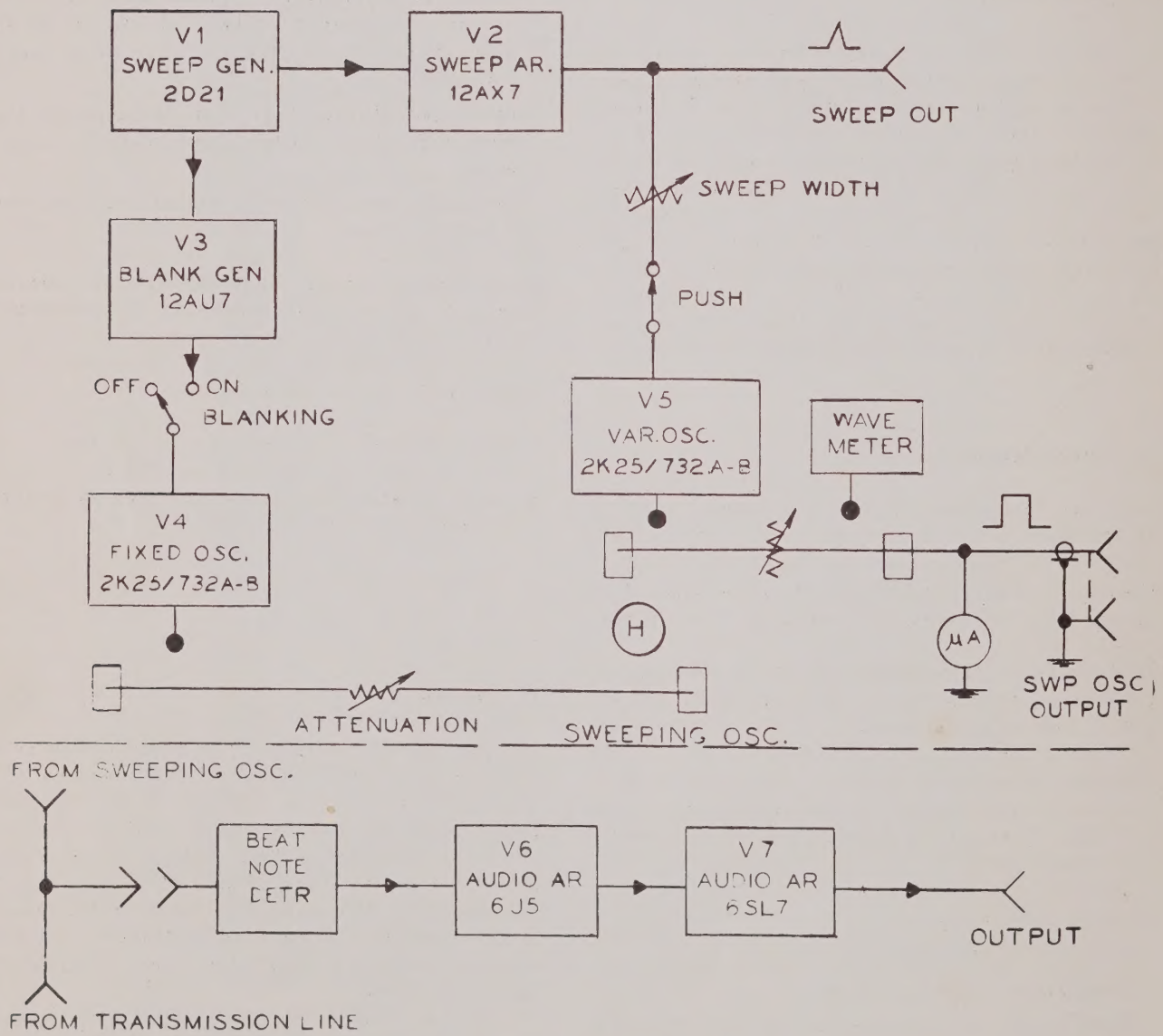


Figure 2, Mega-Match Block Diagram, KA-1601-B

D. GENERAL CIRCUIT DESCRIPTION.

The basic circuits of the MEGA-MATCH are shown in the functional block diagram, Figure 2. They comprise:

1. A "Mega-Sweep" type wide-range sweeping oscillator,
2. A transmission line delay section,
3. A beat note detector,
4. A bandpass audio amplifier, and
5. An electronically regulated power supply.

The sweeping oscillator is a beat frequency oscillator combining the outputs of two type 2K25 or 723 A/B X/band reflex klystrons in a waveguide mixing system. One klystron (the #1) is swept in frequency by the application of a sawtooth voltage to its repeller. This sawtooth sweep voltage is generated by a miniature-type 2D21 thyratron in a conventional gas tube relaxation oscillator circuit and is used both to modulate the #1 klystron, and to develop time-base sweep voltage for the oscilloscope. The outputs of the two klystron oscillators (at frequencies in the 8500 to 9700 mc range) are heterodyned in a 1N23B microwave crystal mixer. The resultant difference frequency is made available at the SWEEPING OSCILLATOR OUTPUT connector. The d-c component of crystal current is fed through a lowpass filter to a current indicating meter which is available for monitoring the output of the klystron oscillators.

The transmission line delay section of the MEGA-MATCH consists of three separate lengths of 53.5-ohm, solid-dielectric cable, assembled in the instrument cabinet and brought out to three sets of connectors on the instrument front panel. Any single length of cable, or combination of lengths, may be selected for a delay line by using the coaxial patch cables provided with the instrument. The single cable lengths measure 200 ft., 66 ft., and 66 ft., respectively, and combine to form alternative lengths of 132 ft., 266 ft., and 332 ft.

In the beat note detector circuit, a 1N23B silicon crystal diode detector is used as the mixer for the r-f signals existing at the sending end of the transmission line system. The detector circuit of the MEGA-MATCH is arranged in a coaxial system.

The beat-note amplifier consists of three stages of audio amplification (passband 300 to 8000 cps), utilizing a 6J5 amplifier triode V-6 and both sections of a 6SL7 dual triode V-7. Power for all the circuits is obtained from an electronically regulated power supply mounted on a separate chassis in the rear of the instrument cabinet. Regulated voltages of +300V and -300V are available, as well as an unregulated filament supply of 6.3 volts. A screw-driver adjustment (R-11 in Figure 11, power supply schematic) is provided for accurate setting of the +300 volts supply. In order to insure frequency stability of the klystron oscillators, ripple on the +300 volts supply is reduced to approximately 0.001 volt and regulation against line voltage fluctuations is provided for line voltages of from 105 to 125 volts.

In operating the MEGA-MATCH, a signal from the sweeping oscillator is sent down the transmission line to the end of the line. Any energy reflected from this point arrives back at the generator or sending end, after a time interval dependent upon the length of the line and the velocity with which the wave travels along the line. In the time elapsed, the frequency of the sweeping oscillator has changed somewhat so that two signals of different frequency exist at the detector, one traveling down the line and one returning to the generator end. The two are heterodyned in the beat note detector and the resultant difference frequency (audio beat note) is amplified in the bandpass amplifier and passed on to the vertical amplifier input terminals of an oscilloscope. At the same time, the sawtooth-voltage wave (generated by the gas-tube relaxation-oscillator circuit and used to frequency modulate the output of the #1 klystron), is applied to the horizontal amplifier input terminals of the oscilloscope to provide the proper reference time base. The resultant oscilloscope display is then one of magnitude-of-reflected-energy (envelope of displayed beat note) vs frequency.

SECTION II
OPERATING INSTRUCTIONS

A. CONTROLS.

Reference should be made to the instrument front panel (Figure 1) or to schematic KC-1304-F (Figure 12). The ON-OFF switch S-1 is a toggle switch which controls the 117-volts, a-c power. A pilot light indicates the presence of a-c power; a 3 ampere fuse F-1 is replaceable on the front panel.

FINE FREQ. ADJ. (#1) is a potentiometer (R-25), which varies the negative voltage applied to the repeller electrode of the swept-frequency klystron, V-5.

PUSH Switch (S-3) is a momentary-type toggle switch which, in its momentary contact position, de-activates V-5 and permits monitoring of the fixed-frequency klystron, V-4, by means of the crystal-current indicating meter.

PEAKING ADJ #2 is a potentiometer (R-30) which varies the negative voltage applied to the repeller electrode of the fixed-frequency klystron V-4.

COARSE FREQUENCY ADJUST control incorporates a mechanical shaft connection to the resonator cavity nut of the swept-frequency klystron and to potentiometer R-24, which varies the repeller potential at V-5. The klystron output frequency is changed by varying the physical dimensions of its cavity.

ATTENUATION control (R-48) includes a rotary drive mechanism which adjusts the position of a carbon card attenuator in the waveguide section associated with the fixed-frequency klystron. It varies the r-f output signal amplitude by attenuating the microwave output of the fixed-frequency oscillator, V-4.

SWEEP WIDTH control (R-21) is a potentiometer which varies the amplitude of the sawtooth sweep voltage applied to the repeller electrode of V-5.

SWEEP RATE control (R-3) is a potentiometer which varies the frequency of the 2D21 relaxation-type sawtooth oscillator over the approximate range of 50 to 100 cps.

FREQUENCY METER is a tunable coaxial-type absorption wavemeter, coupled into the waveguide mixing system for use in measuring the frequency of the r-f output signal.

BLANKING switch (S-2). When this SPST toggle switch is in the ON position, the fixed-frequency oscillator is disabled on alternate half-cycles of operation to produce a clear, zero-voltage reference line on the oscilloscope.

Beat Note Amplifier GAIN control (R-46). This potentiometer varies the amount of signal fed to the grid of the last audio amplifier stage and then, controls the signal amplitude at OUTPUT connector J-10.

B. CONNECTORS.

SWEEPING OSCILLATOR OUTPUT connector (J-2) is a UHF-type female connector at which the r-f output of the sweeping oscillator is available.

SWEEP OUT terminals (J-1) are external binding posts at which the sawtooth voltage generated by the gas-tube relaxation oscillator is available for horizontal deflection of the oscilloscope.

DETECTOR connector is a UHF-type female connector which is an integral part of the coaxial beat-note detector circuit. It is attached to the SWEEPING OSCILLATOR OUTPUT and to the proper delay cable connector through a UB-107 B/U T-adaptor and the patching cables provided with the instrument.

Cable connectors 1 and 2 are UHF-type female connectors which are attached to the ends of a 66-ft. length of 53.5-ohm solid-dielectric flexible cable.

Cable connectors 3 and 4 are UHF-type female connectors to which are attached the ends of another 66-ft. length of 53.5-ohm cable.

Cable connectors 5 and 6 are UHF-type female connectors to which are attached the ends of a 200-ft. length of 53.5-ohm cable.

OUTPUT terminals (J-10) are external binding posts at which the amplified audio beat note is available for vertical deflection of the oscilloscope.

C. ACCESSORIES.

One (1) N-type T-adapter, UG-107 B/U, one male, two female ends.

Two (2) short patch cables (53.5 ohms) each equipped with one (1) VHF UB-176/U male connector and one (1) UHF-type male connector #C1Q49288.

Two (2) short patch cables (53.5 ohms) equipped with two (2) UG-176/U male connectors.

One (1) 60-ft. length of 51.5-ohm low-loss solid-dielectric flexible cable, fitted with UHF-type male connectors.

D. CONNECTIONS.

1. Plug in the T-connector provided with the unit directly to the DETECTOR terminal.

2. Connect the SWEEPING OSCILLATOR OUTPUT to the "right-hand" terminal of the T-connector through a patch cable.

3. Connect the proper cable connector to the "left-hand" terminal of the T-connector through a patch cable.

4. Add additional lengths of cable as desired by connecting the proper cable connectors through a patch cord.

5. For frequencies above 250 mc, use only the external 60-ft. length of cable plugged in directly to the "left-hand" terminal of the T-connector.

6. Connect the SWEEP OUT terminals to the horizontal (X-axis) amplifier input terminals of an oscilloscope.

7. Connect the OUTPUT terminals to the vertical (Y-axis) amplifier input terminals of the same oscilloscope.

E. OPERATION.

1. Set SWEEP WIDTH control completely clockwise (maximum sweep).

2. Adjust SWEEP RATE control to synchronize sweep rate with line-frequency.

3. Set ATTENUATOR control fully counter-clockwise (minimum attenuation, which generally occurs about 8 turns out from full clockwise).

4. Depress the PUSH switch and maximize the meter reading by rotation of PEAKING ADJUST #2.

5. Release switch; rotate FINE FREQ. ADJ. control for maximum current.

6. Adjust the GAIN control of the MEGA-MATCH and the gain control of the oscilloscope Y-axis amplifier to observe the beat-vs-frequency oscilloscope response.

7. Rotate the micrometer head of the FREQUENCY METER until the entire beat-note pattern undergoes a reduction in amplitude (point of minimum amplitude indicates the frequency of the #2 klystron or:

Observe the "dip" on the microammeter reading with the PUSH switch in its depressed position.

8. Rotate the micrometer head of the FREQUENCY METER until a sharp "dip" appears on the oscilloscope display (indicating the frequency of the #1 klystron) or:

Observe the "dip" on the microammeter reading with the PUSH switch released and with SWEEP WIDTH control full counterclockwise.

9. Obtain the frequency at the point of "dip" from the two readings of the wavemeter graduated scale (see paragraph F, of Operating Data).

10. To adjust for a desired frequency, rotate the COARSE FREQUENCY ADJUST control (clockwise to increase frequency; counterclockwise to decrease frequency) and follow along with the wavemeter until the "dip" appears at the proper setting of the wavemeter micrometer head.

11. Back off the FREQUENCY METER until its "dip" no longer affects the displayed pattern.

12. Note the amplitude of the beat-note envelope with the delay line terminated in open or short circuit.

13. Connect desired load in place of open or short circuit.

14. Note amplitude of beat-note envelope with desired load in place.

(For explanation of steps 12, 13 and 14, see Section III.)

F. OPERATING DATA.

1. The Sweeping Oscillator.

a. Klystron Oscillation - Each of the two klystrons operates in one or more modes of oscillation depending upon the value of negative voltage applied to its repeller electrode. The output of a klystron and its electronic tuning range will vary with the particular mode selected by adjustment of the PEAKING ADJUST control. In each mode, the oscillation intensity will be monitored by the crystal-current meter on the control panel, the reading of which rises to a peak indication at the center of each mode.

The fixed-frequency klystron, V-4, should be operated at the center of its maximum output mode (i.e., at the maximum peak-current indication obtained by depressing the PUSH switch to its momentary contact position and adjusting the #2 PEAKING ADJUST control). The swept-frequency oscillator, V-5, should be operated at the center of any of its modes (i.e., at a peak current indication obtained by adjusting the COARSE FREQ. ADJ. control with the PUSH switch in its normal position and the SWEEP WIDTH control at its zero setting), depending upon the maximum sweep width desired.

Note: Any d-c short (e.g., a coil) across the SWEEPING OSCILLATOR OUTPUT connector J-2, will short out the current meter; reduction of the V-4 microwave signal made by turning in the ATTENUATION control, will seriously reduce the d-c component of crystal current available for monitoring V-4. Both of these conditions should be avoided in making the adjustment.

b. Frequency Adjustment - The output frequency of the sweeping oscillator is determined by the difference in frequencies of the two klystrons, V-5 and V-4. The variable klystron, V-5, normally works below V-4 in frequency. For this condition, clockwise rotation of the COARSE FREQUENCY ADJUST raises the r-f output frequency. When the COARSE FREQUENCY ADJUST is rotated more than one turn in making a tuning change, it may be necessary to readjust the FINE FREQ. ADJ. control to restore maximum reading of the current meter.

c. Frequency Measurement - The output frequency of the sweeping oscillator is obtained as a difference function of the measurement of the relative output frequencies of the two klystrons. These measurements are made with the FREQUENCY METER, which absorbs microwave energy at the resonant frequency of its adjustable cavity. When the FREQUENCY METER is tuned to the output frequency of one of the klystrons, a dip will be observed in the reading of the monitoring microammeter. (To observe a "dip" in the output of V-4, the PUSH switch is depressed to its momentary contact position; for V-5, the PUSH switch is maintained in its normal position.) The tunable coaxial wavemeter (FREQUENCY METER) is adjusted by means of a rotary micrometer head which moves along a graduated scale. Readings proportional to the output frequencies of both klystrons may be read directly from the scale at the points of greater microammeter "dip". The difference in these readings, multiplied by the FREQUENCY METER scale factor of approximately 0.5 mc/division (See Tables I and II, Section IV in paragraph G) yields the output frequency in mc.

An alternative method of observing the output absorption "dip" effected by the FREQUENCY METER, utilizes the oscilloscope display as an indicating device. *This is the most convenient method for use in Mega-Match applications.* The "dip" associated with the frequency of the #2 klystron will

appear as a reduction in output occurring over the entire response of beat note vs frequency (i.e., at all displayed frequencies). The "dip" associated with the #1 klystron will appear as either a sharp absorption or a sharp perturbation which moves along the response pattern as the wavemeter micrometer head is adjusted. This latter "dip" may be used to indicate the frequency of any point along the response pattern.

2. Properties of the Delay Transmission Line.

The circuit assembly of the MEGA-MATCH permits the use of either the 53.5-ohm coaxial cable incorporated in the unit, or of other (external) transmission lines. The measurement capability of the instrument will be largely determined by the properties of the transmission line used, i.e., by such parameters of the line as value of characteristic impedance, uniformity of impedance with length, attenuation factor, length of line used and frequency at which the line is operated.

a. Length of Line - The frequency "fineness" or resolution, (See Section III, paragraph A) with which a determination of reflection coefficient-vs-frequency can be made depends upon the time delay section of the MEGA-MATCH. Since the velocity of propagation along the cable is essentially a constant for the type of cable supplied, the frequency resolution will depend only upon the length of line employed (See Section III, paragraph A). The table below lists the total line length of internal 53.5-ohm coaxial cable available and the corresponding time delays and frequency resolutions.

Line Lengths (Polyethylene dielectric cable)	Two-way Delay (Time)	Frequency Resolution
332 ft.	1.0 μsec.	1.0 mc
226 ft.	0.8 μsec.	1.25 mc
200 ft.	0.5 μsec.	1.67 mc
132 ft.	0.4 μsec.	2.5 mc
66 ft.	0.2 μsec.	5.0 mc

b. Line Uniformity - Periodically-spaced small irregularities in the characteristic impedance of a transmission line may be manifest at some frequencies as perturbations superimposed on the oscilloscope display presented by the MEGA-MATCH. The frequencies at which these disturbances occur correspond to half-wave length spacing of the periodic irregularities along the cable. At low levels of beat-note signal these "periodicity" effects may be large enough to add distortion to the beat-note waveform and thus, reduce the accuracy of low reflection coefficient measurements. For this reason, the delay-line cable included with the MEGA-MATCH has been preselected for minimum "periodicity".

c. Line Attenuation - Since all measurements made with the MEGA-MATCH are relative measurements, based on a reference observation which, is itself, a result of the characteristics of the delay system (See Section III), an exact knowledge of the transmission line attenuation is not required. Excessive attenuation, however, is to be avoided; since the minor reflections caused by cable irregularities exert a larger influence on the beat-note pattern when cable attenuation per unit-length is high and the transmission line employed is long. For this reason, the length of reference line chosen for a particular frequency range may often be the result of some compromise.

In general, frequency resolutions of the order of about 4.0 mc's will be satisfactory for VHF and UHF applications, where the higher transmission line attenuation is encountered. Transmission line lengths of the order of 75 ft. may be used at these frequencies without excessive total attenuation. For frequencies below the VHF range, the transmission line attenuation is lower, so that longer cable lengths may be used to achieve the finer absolute frequency resolution usually desired here. In most cases, a frequency resolution to 5% of the center frequency will be satisfactory. The table lists the recommended line lengths to be used for a particular band of frequencies. This list has been established on considerations of line attenuation, frequency resolution and line irregularities.

Frequency Range	Cable Length
10 - 20 mc	332 ft.
20 - 40 mc	266 ft.
40 - 80 mc	200 ft.
80 - 160 mc	132 ft.
160 - 250 mc	66 ft.
above 250 mc	60 ft. (RG-8/U)

SECTION III
THEORY - THE VISUAL DISPLAY

A. THE DEVELOPED BEAT NOTE.

As indicated in Section I-D, the MEGA-MATCH consists essentially of a wide-range sweeping oscillator arranged to impress a frequency-modulated signal on a transmission-line system of finite propagation time. This propagation time, is such that, any instant the reflected energy received back from the far end of the system will be of a measurably different frequency from that being fed into its input.

The pitch of the beat note produced by combining the incident and reflected waves in the beat-note detector circuit is proportional to the rate at which the frequency is being varied and to the propagation time of the transmission-line system. The amplitude of the beat note is proportional to the amplitude of the reflected wave.

With reference to the wave forms in Fig. 3a and 3b, assume that the following conditions prevail:

1. An r-f voltage of amplitude A is linearly frequency-modulated between the limits f_1 and f_2 by a sawtooth waveform of period T.

2. This voltage is applied to a transmission line whose terminating impedance Z_R does not equal its characteristic impedance Z_O.

3. The reflected energy due to this inequality (mismatch) is received back at the input after a delay time τ equal to twice the propagation time along the transmission line.

When attenuation in the transmission line is assumed to be negligible and ρ is taken as the complex transmission line voltage reflection coefficient, equal to $(Z_R - Z_O)/(Z_R + Z_O)$, the voltage amplitude of the reflected wave will be $|\rho|$ times the amplitude of the applied wave. The total frequency excursion Δf of the reflected wave will be the same as that of the applied wave. The frequency of the beat note is given by

$$F = \frac{\tau}{T}(f_2 - f_1) = \frac{\tau \Delta f}{T} \quad \text{where} \qquad \text{(eq. 1)}$$

τ = two-way delay time.

The beat note is sustained for a length of time equal to T-T′, where T′ is the time of the return sweep. At the end of the time, for the brief interval, a transient frequency is set up as the applied wave snaps back from f_2 to f_1 to repeat the sweeping sequence.

To a first order of magnitude, it is necessary that the beat-note frequency be such that, at least one full cycle of the beat note is completed during the time interval T. As is apparent from Fig. 4, this condition must be fulfilled if a closely sinusoidal beat-note waveform is to be obtained. Therefore:

$$T \geq 1/F \qquad \text{(eq. 2)}$$

For the case where T = 1/F, substituting for T in eq. 1, gives

$$\Delta f = \frac{1}{\tau} \qquad \text{(eq. 3)}$$

In order, therefore, to secure at least one full cycle of beat note, the total frequency deviation must equal the inverse of the total propagation time outward and back through the transmission line. The amount of frequency excursion during one cycle of beat note, will determine the frequency resolution of a particular reflection measurement.

For the coaxial cable supplied with the MEGA-MATCH, a straight-forward relationship of frequency resolution (Δf) vs cable length (L) may be derived. The two-way delay time, τ in equation 3, is the product of the velocity of propagation V and the total distance (2L) traversed by the incident and reflected signal. This distance is equal to twice the length of the delay transmission line. Since the velocity of propagation for polyethylene dielectric cable is 66% of the velocity of light, equation 3 becomes

$$\Delta f = \frac{1}{2VL} = \frac{330}{L}; \quad \begin{matrix} \text{where L is in ft.} \\ \Delta f \text{ is in mc.} \end{matrix} \qquad \text{(eq. 4)}$$

Fig. 3c illustrates the amplitude vs time relationship existing at the beat-note detector when the frequency deviation is twice that of the case where T = 1/F. For each frequency excursion, two cycles of beat note are developed. Similarly,

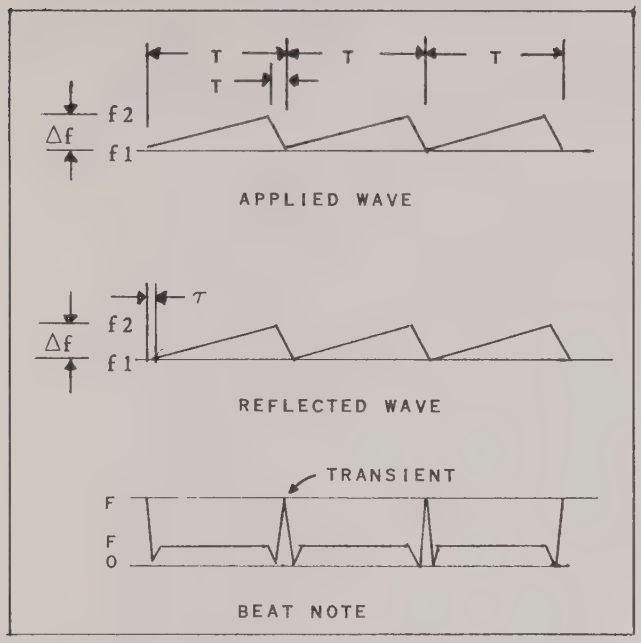


Fig. 3a - Frequency vs. time relationship existing at the beat note detector.

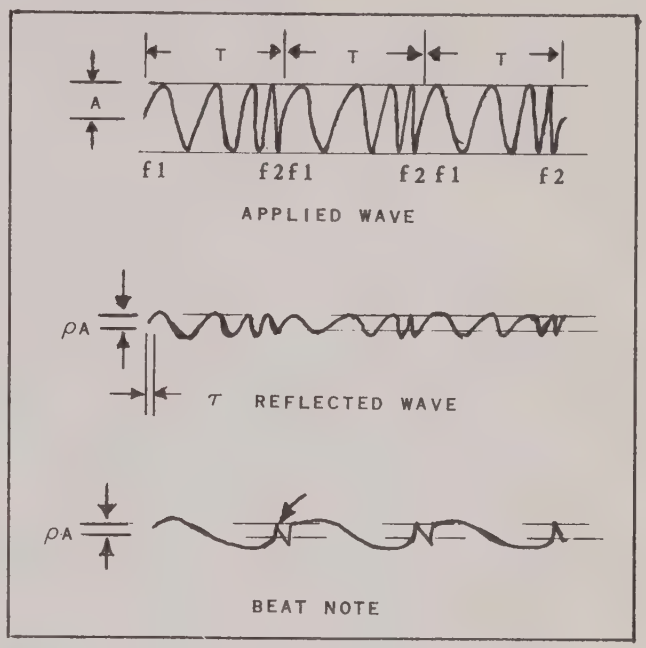


Fig. 3b - Amplitude vs. time relationship existing at the beat note detector.

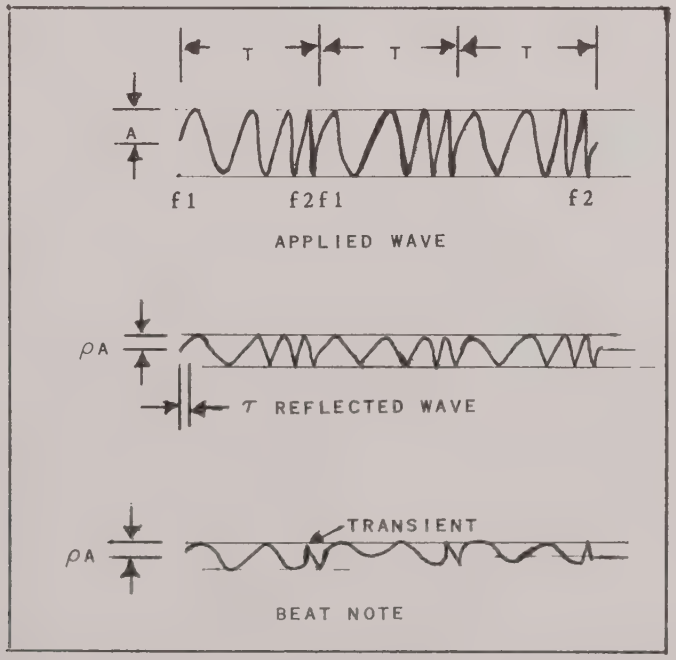


Fig. 3c - Amplitude vs. time relationship existing at the beat note detector for $f=(f_3-f_1)=2(f_z-f_1)$.

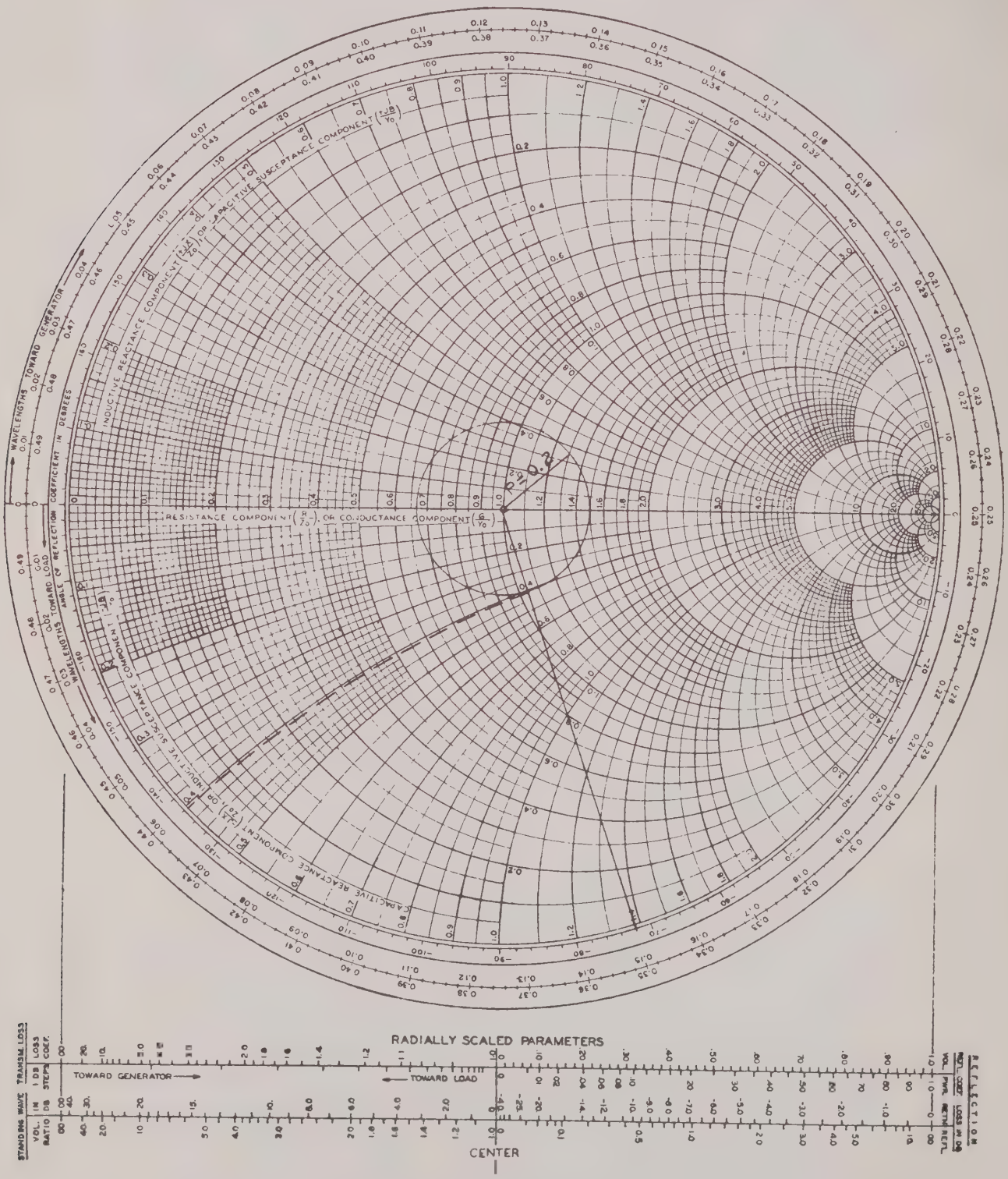


Figure 4, Impedance of Admittance Coordinates (Smith Chart).

for three times the frequency deviation, three cycles are developed; for four times the frequency deviation, four cycles, and so on. In each case, the frequency separation in mc between adjacent beat-note peaks, is essentially a constant equal to the inverse of the propagation time in microseconds outward and back through the wave guide.

In normal operation of the MEGA-MATCH, the frequency deviation of the klystron is adjusted so that significantly more than one cycle of sine wave beat note per sweep excursion is developed, depending upon the frequency sweep width employed. It can be seen from the table in Section II, F-2, that the frequency resolution (i.e., the frequency between sine-wave peaks of the displayed beat note) varies from about 1.0 to 5.0 mc for the transmission line included with the MEGA-MATCH. Since the maximum sweep width of the MEGA-MATCH is well over 30-mc, 8 or more cycles of beat note per sweep excursion may be displayed. For best results, it is recommended that the MEGA-MATCH always be set up to operate with no less than 6 complete beat-note cycles per sweep excursion.

B. THE BEAT-NOTE ENVELOPE.

Figures 5a and 5b are representations of typical oscilloscope displays obtained by using the MEGA-MATCH. Figure 5a is a visual representation of total reflection; Figure 5b is a visual representation of narrow band near matching to the transmission line.

The envelope of the displayed beat note is a measure of the reflection coefficient of a termination at the end of the transmission line. Since there is attenuation in the line, the amplitude of the reflected voltage wave, as received back at the beat-note detector, is not exactly equal to ρ times the voltage amplitude of the applied wave, but is $N^2\rho$ times this amplitude, where N is the voltage attenuation ratio suffered by the wave in traversing the length of the line one way. It remains true, however, that the amplitude of the reflected wave received back at the beat-note detector is proportional to the magnitude of the reflection coefficient. For an open-circuited or short-circuited termination of the transmission line, the magnitude of ρ is always unity. The ratio of the amplitude of the beat-note envelope obtained with the line terminated in the desired impedance, to that obtained for open or short circuit, is then the reflection coefficient of the termination under test.

As indicated in Figures 5a and 5b, the displayed beat-note cycles are modulated by an envelope whose amplitude represents the amount of reflected energy as a function of instantaneous frequency. The decreasing amplitude of the envelope follows from the increase of cable attenuation with frequency.

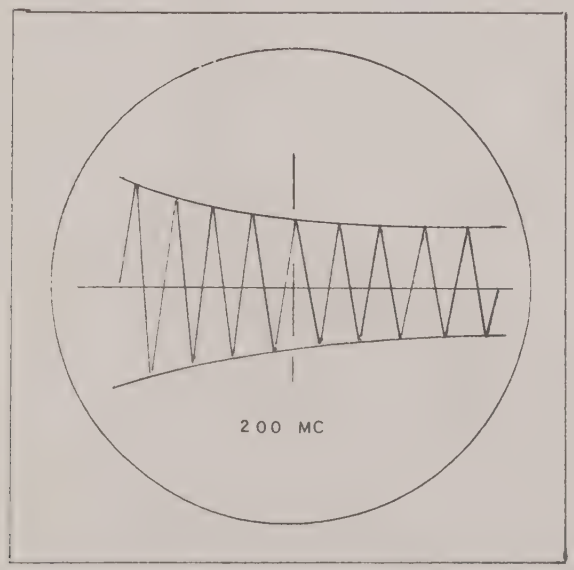


Fig. 5a - Visual presentation of total reflection on the oscilloscope screen.

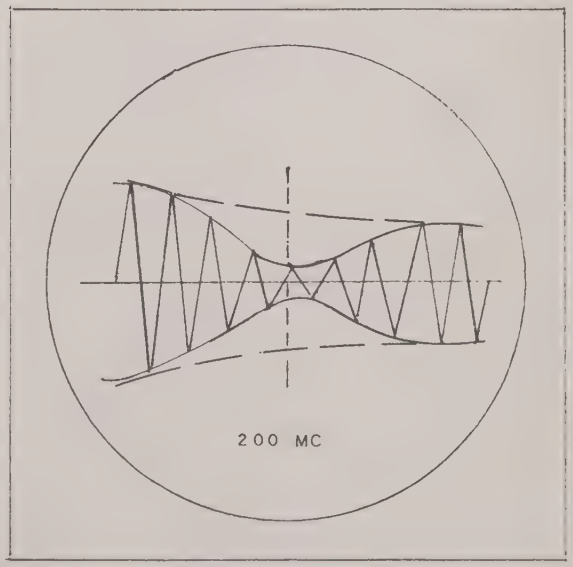


Fig. 5b - Visual presentation of a narrow band near-match on the oscilloscope screen.

SECTION IV
APPLICATIONS

A. EMPIRICAL TECHNIQUE OF MINIMIZING MISMATCH.

In this, its major application, the MEGA-MATCH is set up to display the reflection coefficient of a particular device over a desired frequency range, as described in Section II-F. The degree of mismatch over the band is given by the ratio of the amplitude of the displayed beat-note envelope, obtained with the desired termination at the end of the line, to that obtained with the line terminated in open or short circuit. Adjustment of the circuit parameters of the load element under test, may then be made for optimum match to the transmission line over the desired frequency range; i.e., for the lowest level of beat-note envelope. As can be seen in Fig. 5b, the reflected energy approaches zero in the region of 200 mc. At either extreme of the frequency excursion the reflected energy approaches that which would be obtained if the transmission line were terminated in an open circuit.

B. MEASUREMENT OF MAGNITUDE OF THE REFLECTION COEFFICIENT.

The reflection coefficient magnitude-vs-frequency of a load element may be measured directly with the MEGA-MATCH. Reflection coefficient is determined by comparison of the amplitude of the beat note obtained with the line terminated in open or short circuit. Since the latter condition introduces total reflection, or a reflection coefficient of unity, the ratio of the first beat-note amplitude to the second, at any particular frequency along the sweep, is the reflection coefficient of the test termination at that frequency. Measurements are made in terms of of the vertical deflection of the oscilloscope.

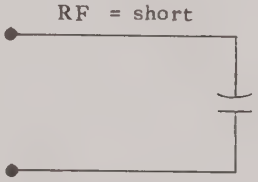
For example in Fig. 5b, the dotted line indicates the envelope of the beat-note display obtained with the transmission delay line open or short circuited; i.e., a reflection coefficient of unity. The GAIN control of the MEGA-MATCH and the Y-axis gain control of the oscilloscope, are adjusted so that the amplitude of the beat-note at 200 mc measures 20 units of vertical deflection. The amplitude of the beat note, obtained with the load element in place at 200 mc, measures 4 units of vertical deflection. The reflection coefficient of the test termination at 200 mc is then 4/20 or 0.2.

For the case of purely resistive terminations, same magnitude of ρ (and, therefore, the same amplitude of beat-note envelope) will be obtained for two values of mismatched resistance, one higher than the characteristic impedance of the delay cable and one lower. In practice, a mismatched terminating resistance may be established as above or below the cable characteristic impedance by shunting across it a resistor of about 5 times the Z_O of the cable. If the amplitude of the beat-note envelope is increased (i.e., greater reflection), the terminating resistance is lower than the Z_O of the cable; if the amplitude of the beat-note envelope is decreased (less reflection), the terminating resistance is above the Z_O of the cable.

In making measurements with the MEGA-MATCH, precautions should be taken to maintain approximately the same d-c component of terminating impedance for both the reference display and the test measurement. This must be done in order to maintain the mixer crystal of the sweeping oscillator at a constant bias level.

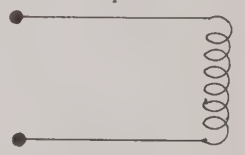
The following terminations may be used to establish the reference conditions of RF open or short circuit for varied conditions of DC terminations:

1. DC = open
   RF = short



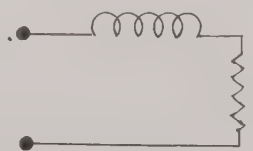
Large capacitance

2. DC = short
   RF = open



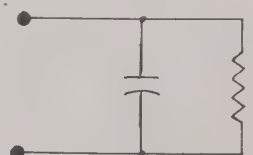
Large inductance with small distributed capacitance.

3. DC = R
   RF = open



Large inductance

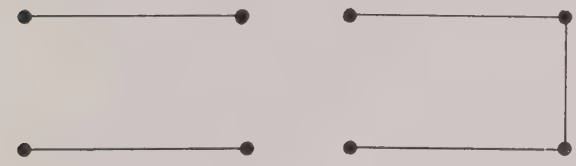
4. DC = R
   RF = short



Large capacitance

5. DC = open
   RF = open

6. DC = short
   RF = short



C. DETERMINATION OF VOLTAGE STANDING-WAVE-RATIO AND COMPLEX TERMINATING IMPEDANCE.

The relationship of reflection coefficient to voltage standing wave ratio may be expressed as:

$$VSWR = \frac{1 + /\rho/}{1 - /\rho/} \qquad \text{(eq. 5)}$$

where ρ is the voltage reflection coefficient.

For interpretation of the MEGA-MATCH display in terms of VSWR, equation 5 may be employed, or reference may be made to the Smith Chart (Fig. 4). It will be seen that the graduated scales found under the heading Radially Scaled Parameters, include scales of both voltage reflection coefficient and voltage-standing-wave ratio. A quick conversion from one to the other may be made by the use of dividers, measuring equal distances along the scales outward from their common center line.

The complex terminating impedance of the load element under test may be found from the relationship:

$$Z_R = Z_O \frac{1 + \rho}{1 - \rho} \qquad \text{(eq. 6)}$$

where Z_R = complex terminating impedance

Z_O = cable characteristic impedance

ρ = complex voltage reflection coefficient

In general, the impedance is more readily found as described in paragraph E.

D. MEASUREMENT OF PHASE ANGEL OF REFLECTION COEFFICIENT.

The reflection coefficient phase angle-vs-frequency characteristic may be determined by a marker "birdie" (injected by a suitable oscillator) to measure the frequency at which each of the beat-note peaks occurs with the transmission delay line terminated in open or short circuit. Let the measured frequencies of these beat-note peaks be given by f_1, f_2, f_3.... A similar measurement may then be made with the cable terminated in the desired load, yielding new frequencies of the beat-note peaks at f_1, f_2, f_3,.... As discussed in Section III, the frequency separation (Δf) between adjacent beat-note peaks (f_1, f_2, f_3...) is a constant dependent only upon the length of transmission delay line used. Since this frequency separation corresponds to 360° of phase, the reflection coefficient phase angle (θ) at any sine-wave peak along the oscilloscope display will be given by:

Case 1 (Open Circuit Reference):

$$\theta = \frac{f_n' - f_n}{\Delta f} \times 360° \qquad \text{(eq. 7)}$$

Case 2 (Short Circuit Reference):

$$\theta = \frac{f_n - f_n'}{\Delta f} \times 360°$$

Where f_n' = the frequency in mc of a beat-note peak obtained with the cable terminated in open or short circuit.

f_n = the frequency in mc of the same beat-note peak obtained with the cable terminated in the desired load.

Δf = frequency resolution in mc.

The phase angle may be established as leading or lagging by noting the apparent direction of movement taken by the marker birdie when the cable is terminated in the desired load.

Here again the determination of the phase angle of the reflection coefficient (as in the determination of its magnitude), is made with respect to a reference condition as shown in Figure 6. The two reference conditions, open and short circuit, produce "positive" beat-note peaks which are 180° removed in phase. In Figure 6, the solid curve indicates the open circuit termination

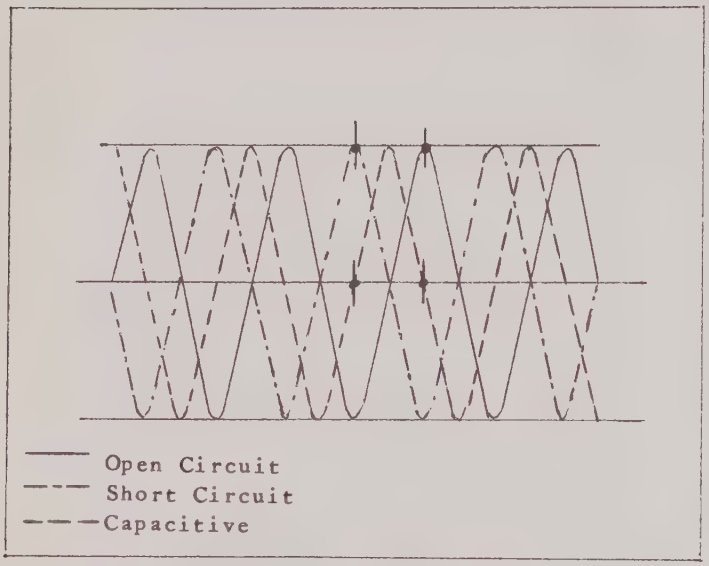


Fig. 6 - Phase Relationships of the Cable Terminations

and the dotted line, the condition established when the cable is terminated in a purely capacitive load. If the reference used were open circuit and the marker birdie were located at a positive peak, the termination of the cable in a capacitive load would shift the beat note to the left and thus, apparently displace the marker birdie to some point along the descending slope of the beat-note wave. If the reference used were short circuit, the beat note would be shifted to the right of an open circuit reference and to the left of a short circuit reference.

In practice, those conditions may be determined as follows:

1. Open-circuit reference

a. If it is necessary to increase the frequency of the auxiliary oscillator to mark the peaks of the sine-wave beat notes, an inductive load is indicated.

b. If it is necessary to decrease the frequency of the auxiliary oscillator to mark the peaks of the sine-wave beat notes, a capacitive load is indicated.

For example, if the frequency of the marker oscillator in marking the peak of the beat note obtained with the cable open circuited were 200 mc, and the frequency with the load impedance attached were 199 mc, the phase angle would be established as negative. Since the recommended length of delay line for these frequencies measures 66 ft., from equation 4, the frequency resolution of the measurement will be:

$$\Delta f = \frac{330}{L} = \frac{330}{66} = .5 \text{ mc}$$

Since $f_n' - f_n$ in eq. 7 will be equal to 199 mc minus 200 mc, or minus 1 mc, eq. 7 becomes:

$$\theta = \frac{1}{-5}(360) = -72^\circ$$

Note: Coupling of the marker oscillator to the MEGA-MATCH circuit should be made at a point between the output circuit of the sweeping oscillator and the beat-note detector circuit. This may be accomplished by means of a series connection between the SWEEPING OSCILLATOR OUTPUT and DETECTOR connectors, or by means of a T connector plugged in directly to the DETECTOR connector.

If the load element under test is an antenna, the marking signal may be radiated to it from a second antenna, or length of lead, and picked up at the termination without disturbing the measurements being made.

E. DETERMINATION OF THE RESISTIVE AND REACTIVE COMPONENTS OF THE TERMINATING IMPEDANCE.

The magnitude and phase angle of the reflection coefficient at a particular frequency may be found as described above. This data may then be applied to a Smith Chart (Fig. 4) and the resistive and reactive components of the terminating impedance obtained.

If a reflection coefficient of magnitude 0.2 and phase angle -72° (as found above) is assumed, the Smith Chart may be employed as follows:

1. Construct a straight line which starts at the center point of the outer circle and connect to the periphery of the circle at the -72° point on its peripheral scale labeled Angle of Reflection Coefficient.

2. Using dividers, measure off along the Vol. Refl. Coef. scale (located at the bottom of the chart under the heading Radially Scaled Parameters) a distance equal to a reflection coefficient of 0.2.

3. With this distance as a radius, describe an arc about the center point of the outer circle until it intersects with the line of step 1.

4. Since this intersection is also an intersection of the Resistance Component and Capacitive Reactance Component scales of the Smith Chart, the complex impedance (equal to (1.25 - j0.41) in normalized values) may be read directly from the chart.

5. Multiplication of the normalized value by the Z_O of the cable will yield the actual complex impedance, 53.5 (1.25 - j0.41) = 65.1 - j26.8 ohms.

F. OPERATION AT IMPEDANCE LEVELS OTHER THAN 50 OHMS.

The MEGA-MATCH may be used at any conventional transmission-line impedance level depending upon the characteristic impedance of the delay line used. Selection of proper external transmission line should be made on the basis of the cable properties discussed in Section II.

For measurement of balanced impedances, an external length of balanced transmission line of the twin-lead type, developed for use with television and FM receivers, may be used as an external delay line. In order to minimize pick-up from ambient electromagnetic fields, the twin lead may be wound around a cardboard carton about 4′ x 4′ x 4′, with the turns spaced about 2 inches apart. The twin-lead line should be kept straight and free from kinks to avoid introducing irregularities in its characteristic impedance. Connection of external cable of other than 50-ohm characteristic impedance to the DETECTOR connector of the MEGA-MATCH, should be made through an impedance matching transformer, or resistive matching pad, to minimize the effects of second-time reflected waves.

G. METHODS OF MEASURING FREQUENCY.

The following methods apply for those applications in which the sweeping oscillator is used independently.

Use of Wavemeter with Oscilloscope Display

1. Measurement of Absolute Frequency:

When the sweeping oscillator is in use with a test circuit and oscilloscope, the FREQUENCY METER can be used to identify frequencies within the passband. The accuracy of this measurement is approximately 1 mc. To make this measurement the following procedure should be used:

a. Rotate the FREQUENCY METER control until the entire pattern on the oscilloscope decreases to a minimum amplitude. Note the reading on the FREQUENCY METER scale.

b. Rotate the FREQUENCY METER until the minimum of the visual absorption dip, which appears on the oscilloscope, coincides with the point at which frequency is to be read. Note the reading on the FREQUENCY METER scale and obtain the difference between this reading and the one obtained in (a) above.

c. Apply the proper multiplying factor from Table 1 to obtain the frequency in megacycles of the point on the sweep, at which the absorption dip was positioned.

2. Measurement of Frequency Differences:

The FREQUENCY METER can be used to measure frequency difference along the oscilloscope display on broad-band displays. The dip, which appears on the display as the FREQUENCY METER is varied, can be set at two successive points on the display between which the frequency difference is desired. The difference between the micrometer readings obtained from FREQUENCY METER settings, can then be multiplied by the factors in Table II to obtain the frequency difference in megacycles.

3. Calibration Correction for the FREQUENCY METER:

In using the FREQUENCY METER, a factor must be used to multiply the difference between the two micrometer scale readings. For rough measurements, a factor of 0.5 may be used. For more accurate determination, factors as indicated in Table I below should should be used.

Table I, (Absolute Frequency)

FREQUENCY METER READING DIFFERENCE (#2 KLYSTRON - #1 KLYSTRON)	MULTIPLY DIFFERENCE BY:
0 TO 100	0.50
100 TO 400	0.49
400 TO 725	0.48
725 TO 1250	0.47
1250 TO 1600	0.46
1600 TO 1800	0.45

For determining the frequency difference along the sweep, the following correction factors should be used:

Table II

MICROMETER SCALE READINGS BETWEEN	MULTIPLY DIFFERENCE BY:
1900 AND 1800	0.50
1800 AND 1600	0.49
1600 AND 1400	0.48
1400 AND 1200	0.47
1200 AND 1000	0.46
1000 AND 750	0.45
750 AND 500	0.44
500 AND 300	0.43
300 AND 0	0.42

SECTION V
MAINTENANCE

A. LOW SWEEPING OSCILLATOR OUTPUT SIGNAL.

Decrease of r-f output signal from the sweeping oscillator is, in most cases, accompanied by a decrease in d-c current indication on the panel meter.

1. If the panel-meter indication is low or equal to zero, with peaking switch both in normal and in depressed position, a weak microwave mixer crystal is usually indicated. Remove crystal as described below, test and replace, if defective, with a new 1N23B or 1N21B.

2. If panel-meter indication is low or equal to zero with panel switch depressed, but normal with switch released, a defective #2 klystron is indicated.

3. If panel-meter indication is low or equal to zero with panel switch released, but normal with switch depressed, a defective #1 klystron is indicated.

4. Reversing the klystrons to determine whether the current indications follow the tubes will indicate whether it is the tubes, or the associated circuits which are at fault.

B. REMOVAL OF MICROWAVE MIXER CRYSTALS.

The microwave mixer crystal is inserted in a chuck at the left end of the waveguide, just back of the SWEEPING OSCILLATOR OUTPUT connector. To remove the crystal, loosen the thumb-screw and lift the crystal by grasping the crystal flange with a pair of cross cutters and lifting. To replace, drop the crystal gently into the chuck with tip connection down. Rock crystal from side-to-side while pressing down gently. When crystal is firmly seated all the way in, tighten the screw by hand.

C. CORRECTING FOR LOW SENSITIVITY OF MEGA-MATCH.

A decrease in sensitivity of the MEGA-MATCH may be brought about by low sweeping-oscillator output, or by aging of the beat-note amplifier tubes, or of the 1N23B crystal mixer in the beat-note detector circuit.

The 1N23B beat-note detector crystal is assembled in a coaxial system (see schematic, KC-1304-F) mounted inside the front panel and attached directly to the DETECTOR connector.

To remove the crystal:

1. Unsolder the 10-ohm resistor connected to the button condenser.

2. Disengage the barrel sleeve-nut and gently lift the barrel assembly from the base.

3. Disengage the button condenser and remove the button condenser and crystal.

4. Unscrew the crystal from the button condenser.

It should be noted that the 1N23B crystals used in the coaxial beat-note detector are of the screw-mount type. Replacement crystals may be obtained from the factory.

D. CRYSTAL TESTING.

To determine whether a 1N23B crystal is defective, check the resistance between the connecting tip and flange with a standard ohmmeter. Set the meter for readings on the Rx100 scale. Note resistance. Reverse polarity of leads from the ohmmeter at the crystal and note this resistance. One of the two resistance readings should be approximately 200 ohms and the other above 5000 ohms. The high resistance figure on a bad crystal will be low and, in the case of a completely defective crystal, approximately equal to the low resistance value; or sometimes both resistances will be high.

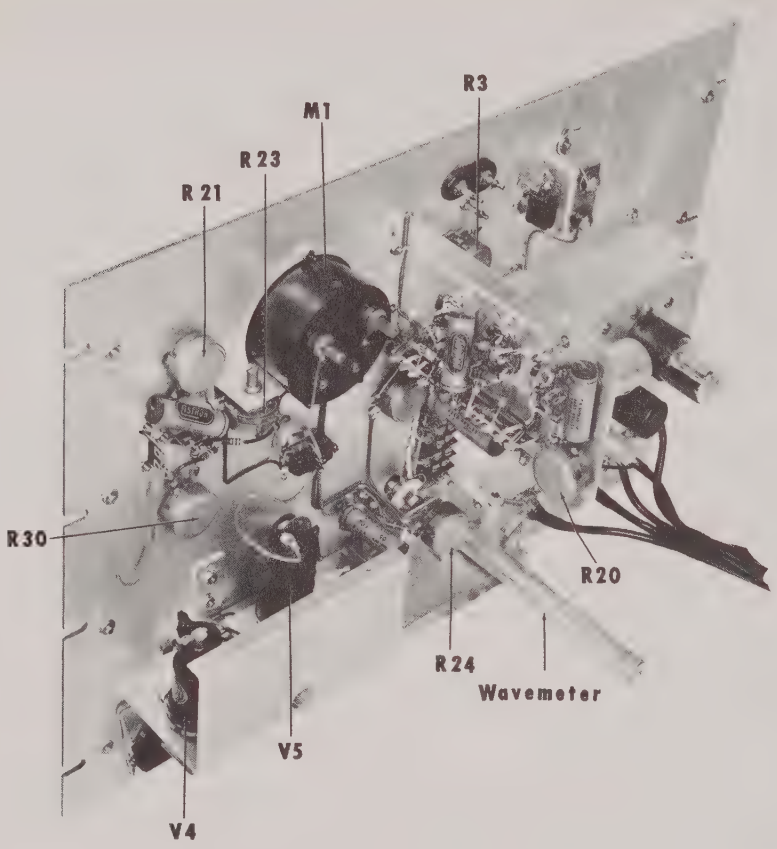


Figure 7, Behind-the-panel View Shows Klystrons V-4, V-5.

E. CRYSTAL PROTECTION FOR INDEPENDENT SWEEPING-OSCILLATOR APPLICATIONS.

1. The chassis under test and other equipment used, should be bonded to the chassis of the MEGA-MATCH before the r-f output cable is used. This bond should be maintained throughout the test. Do not depend on the shield of the r-f cable for this connection. Test-chassis are frequently above ground potential at a-c line frequency, and currents can be passed through the detector if the hot-side of the r-f cable touches the chassis before a ground is made.

2. For applications in a frequency range above 15 mc, a 100$\mu\mu$f condenser should be used in series with the hot-side of the r-f cable at the test circuit. Tape the exposed portions of the connection between the cable and the series condenser.

3. Avoid connection of the r-f cable to any point on which a d-c potential exists.

4. Do not use auxiliary marker equipment in parallel with the SWEEPING OSCILLATOR OUTPUT if the marker output levels are greater than 2.0 volts.

Careful attention to the details itemized above will reduce crystal-detector failures to a great degree.

F. KLYSTRON REPLACEMENT.

The two klystrons V-4 and V-5 are located in a shield box attached to the right rear of the panel (Fig. 7). To replace klystrons, remove the two screws at the top of the shield box and remove the top. Note that the metal shells of the klystrons are at +300-volts and the power switch should be turned OFF before contact is made with the tubes. The fixed frequency (#2) klystron is located to the right when viewed from the front of panel.

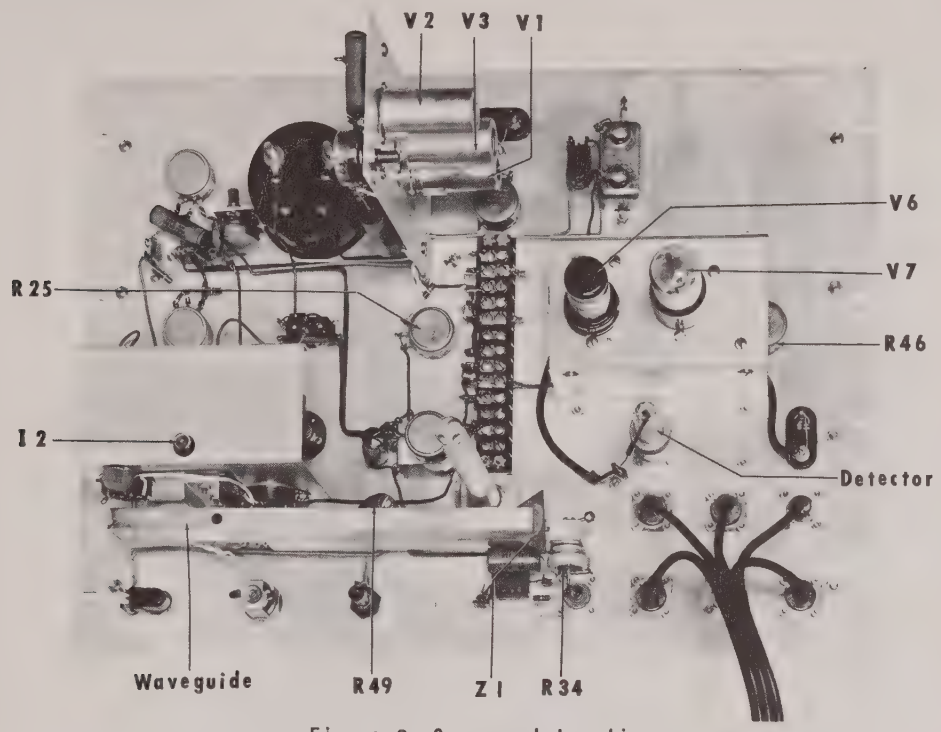


Figure 8, Component Locations.

The variable-frequency or swept klystron (#1) is located to the left when viewed from the front panel. To replace the #2 klystron, remove the top cap connection and carefully withdraw tube from socket. Insert new tube, taking care to insert probe into the large hole socket. The tube should be rocked as it is lowered, so that the probe engages the waveguide beneath. A similar procedure is followed in replacing klystron #1, except that the COARSE FREQ. ADJ. knob and shaft assembly must be moved away from the panel about ½ inch, disengaging the cavity tuning-nut on klystron #1. When the tube is replaced, the COARSE FREQ. ADJ. assembly must be pushed in to re-engage the cavity tuning-nut.

After klystron #2 is replaced, carry out the procedure outlined in Section II (Oscillator Peaking). The cavity-nut must then be adjusted to obtain a dip on the meter with the PUSH switch on the panel depressed and the wavemeter set between 1850 and 1950. An insulated wrench just be used on this nut, or the power turned OFF before contact is made with it.

The klystrons are fused with a protective lamp (I-2) which is located on the terminal strip to the left-rear of the panel. When a shorted klystron is replaced, it is necessary to replace this lamp.

G. FUSE REPLACEMENT.

The a-c power to the Mega-Sweep is fused by a 3 ampere fuse (F-1) screwed into a fuse holder from the front panel.

H. ADJUSTMENT FOR 1000 MEGACYCLE OPERATION.

The sweeping oscillator is normally adjusted for best operation in the range of 0.1 to 500 mc, but is capable of signal outputs to 1000 mc. To obtain a range up to 1000 mc, remove the klystron shield box top at the right-rear of the panel. Adjust the cavity-nut on #2 klystron (tube to the right). Since the shell of this tube is at +300 volts, an insulated wrench must be used or the power turned OFF before adjustment is made. With the PUSH switch depressed and ATTENUATION turned completely counterclockwise, and PEAKING ADJ. #2 adjusted for maximum, the cavity-nut should be rotated for a dip on the meter, with FREQUENCY METER adjusted between 1980 and 2000. Setting the variable klystron (#1) for a dip with the FREQUENCY METER below zero, then allows frequencies around 1000 mc to be obtained.

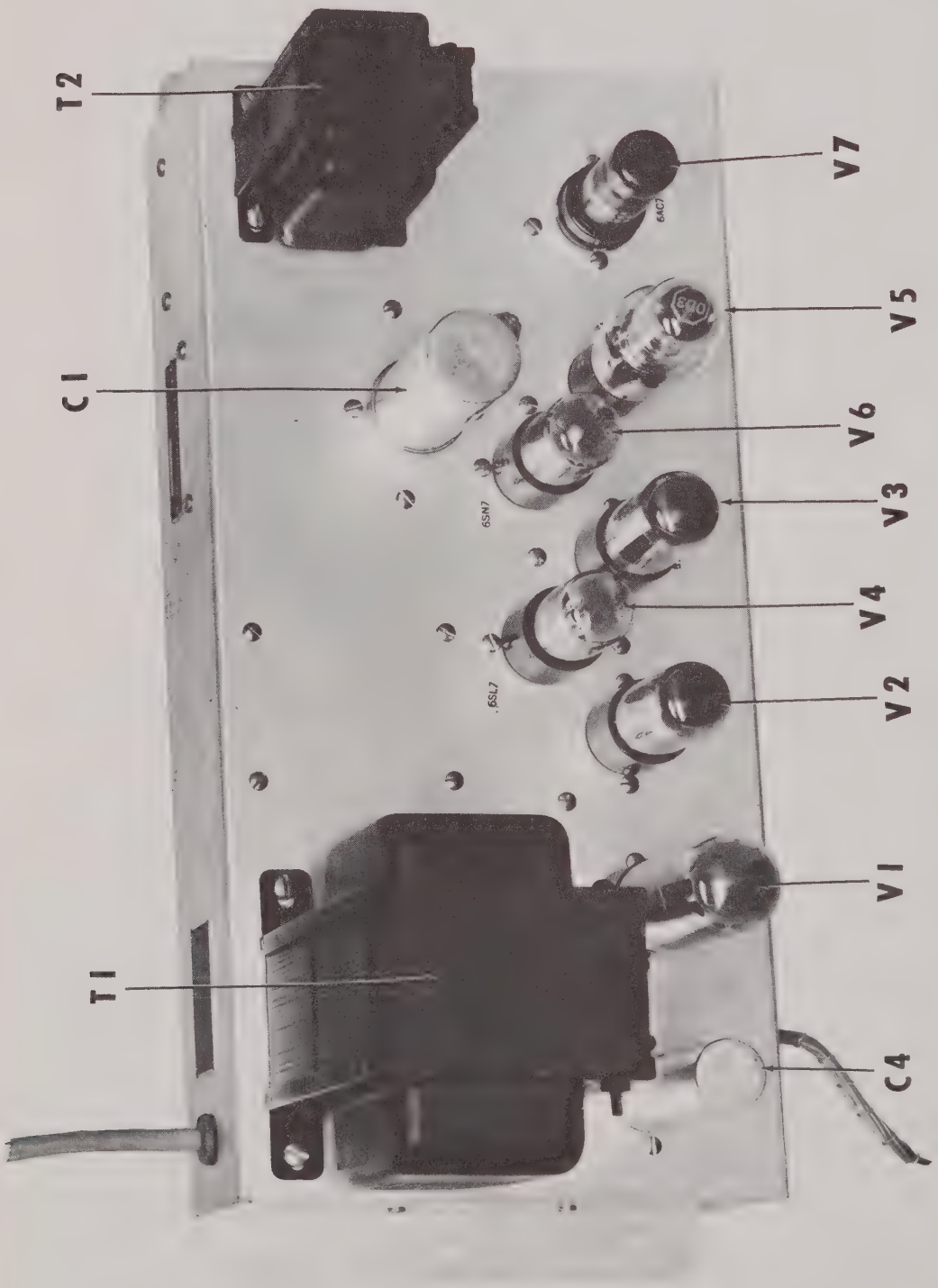


Figure 9, Power-Supply Section, Top View.

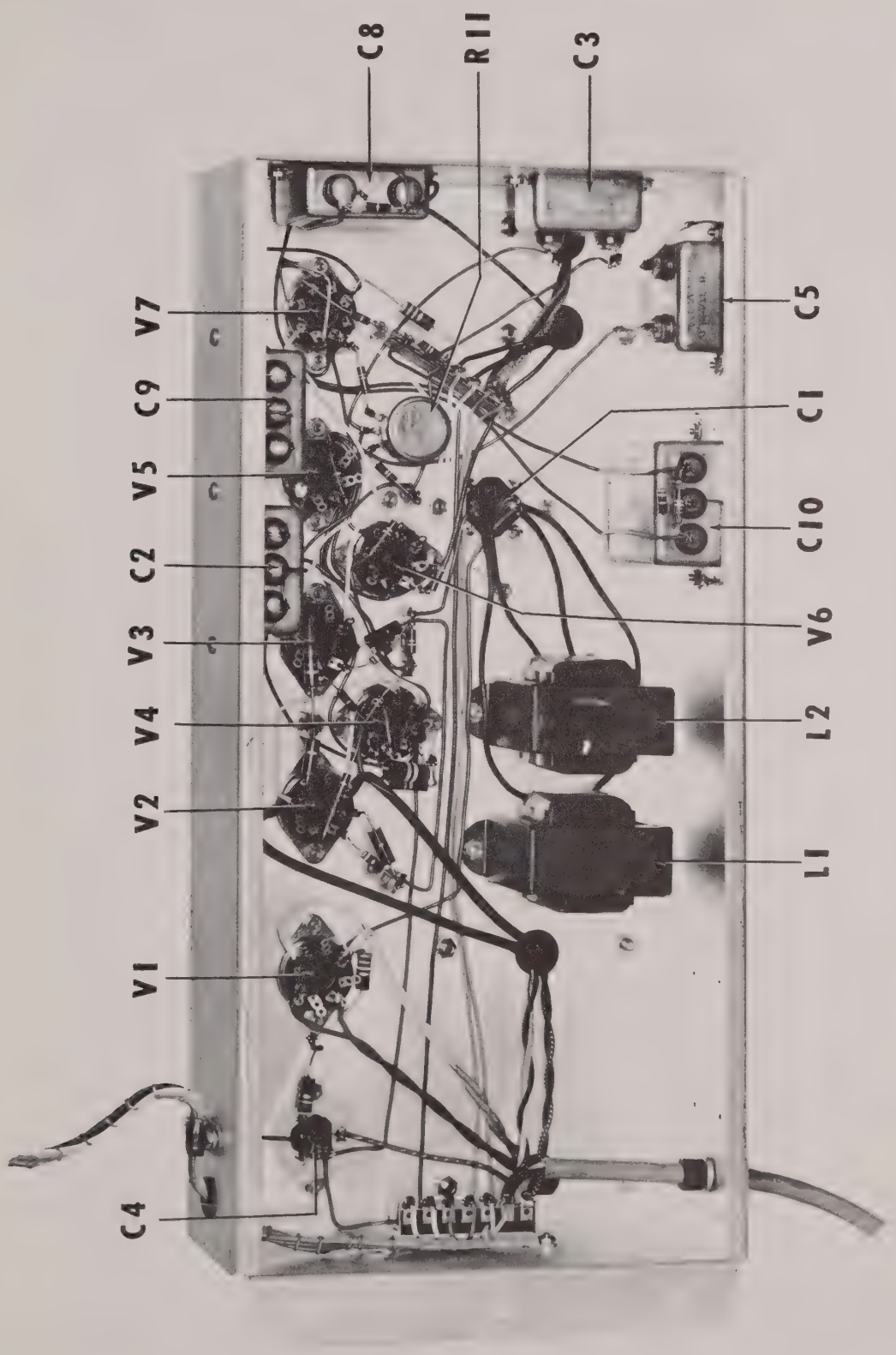


Figure 10, Power-Supply Section, Bottom View

SECTION VI
PARTS LISTS

A. POWER SUPPLY PARTS LIST.

Circuit Symbol No.	Description	Kay Part No.
	RESISTORS: (UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE RESISTORS.	
R-1	330 K, 1W	3341-G
R-2	390	3911-E
R-3	51, 1W	5101-G
R-4	120 K	1241-E
R-5	220	2211-E
R-6	100, 1W	1011-G
R-7	270 K	2741-E
R-8	120 K	1241-E
R-9	82 K	8231-E
R-10	82 K	8231-E
R-11	25 K, 2W, VARIABLE COMPOSITION	114
R-12	10 K, 2W	1031-H
R-13	2.7 K	2721-E
R-14	82 K, 1W	8231-G
R-15	220	2211-E
R-16	390	3911-E
R-17	100, 1W	1011-G
R-18	33K, 1W	3331-G
R-19	680 K	6841-E
R-20	680 K	6841-E
R-21	10 K, 1W	1031-G
R-22	120	1211-E
R-23	47 K, 1W	4731-G
R-24	1 M	1051-E
R-25	4.7 K	4721-E
R-26	51, 1W	5101-G
	CAPACITORS:	
C-1 A-B	DUAL ELECTROLYTIC, 20-20μF, 500V	330
C-2	BATHTUB, 2 x 1μF, 600V	1452
C-3	BATHTUB, 0.5μF, 600V	325
C-4 A-B	DUAL ELECTROLYTIC, 20-20μF, 450V	331
C-5	BATHTUB, 0.5μF, 600V	325
C-6	CERAMIC, 0.01μF, 500V	2633
C-7	NOT USED	
C-8	BATHTUB, 1μF, 600V	326
C-9	BATHTUB, 2 x 1μF, 600V	1452
C-10 A-B	BATHTUB, 2 x 1μF, 600V	1452
	TUBES:	
V-1	5U4	5U4
V-2	6Y6	6Y6
V-3	6Y6	6Y6
V-4	6SL7	6SL7
V-5	VR150	VR150
V-6	6SN7	6SN7
V-7	6AC7	6AC7
	MISCELLANEOUS:	
L-1	CHOKE, 10 HENRY	323
L-2	CHOKE, 10 HENRY	323
T-1	TRANSFORMER, POWER	320
T-2	TRANSFORMER, POWER	319

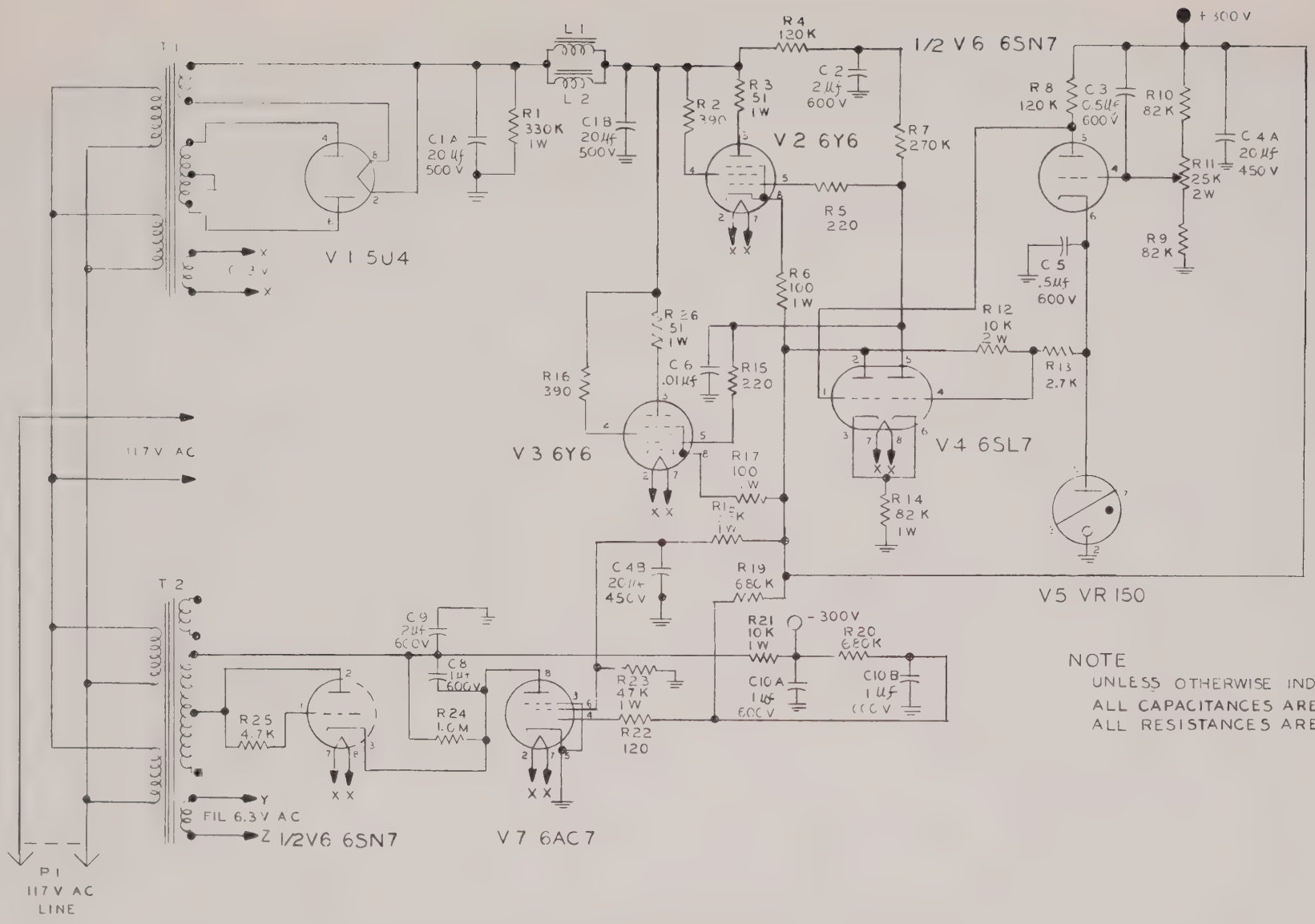


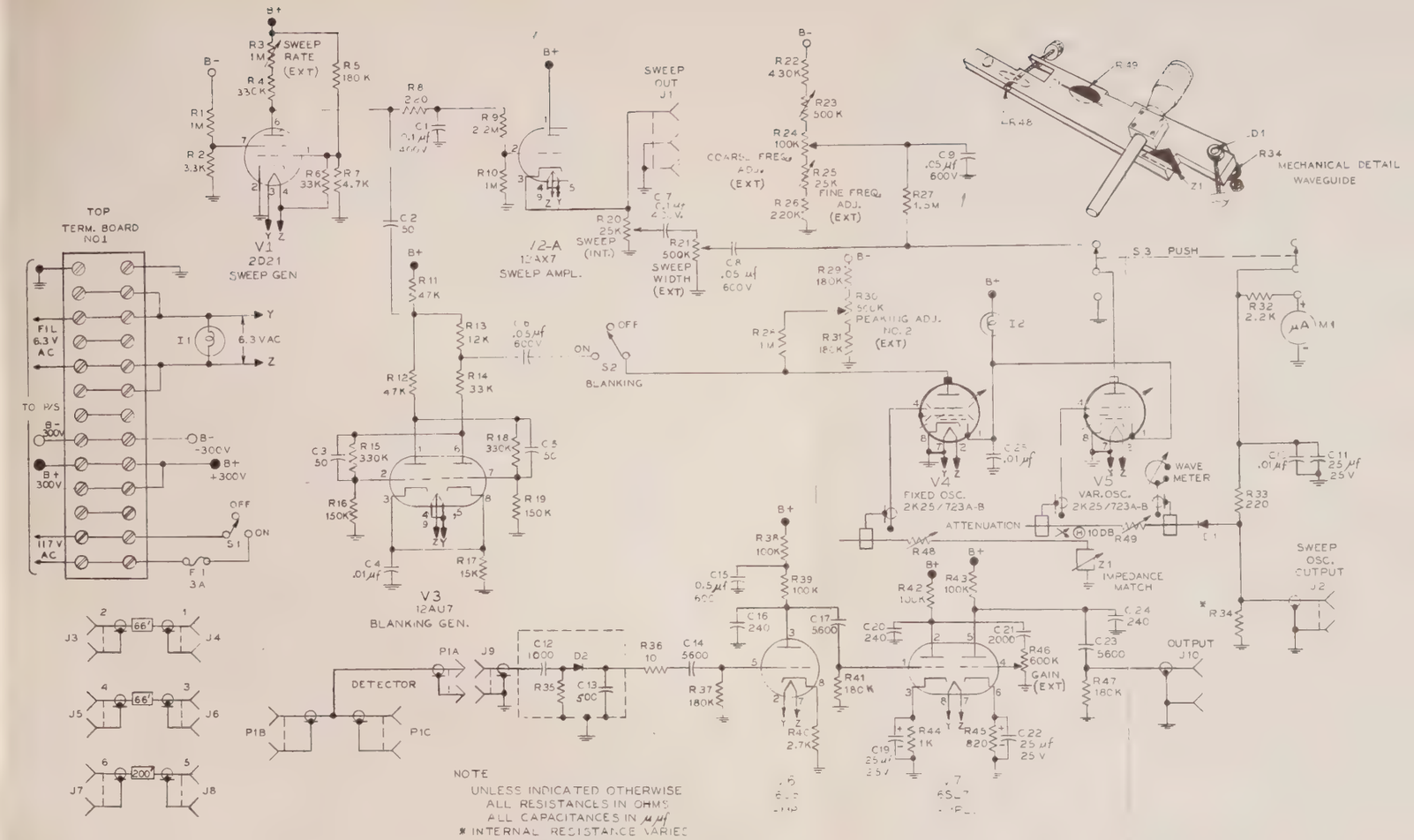
Figure 11, Schematic KB-1303-C, Power Supply.

B. MEGA-MATCH PARTS LIST.

Circuit Symbol No.	Description	Kay Part No.
	CAPACITORS: (ALL CAPACITORS IN μμF UNLESS OTHERWISE INDICATED).	
C-1	0.1μF, 400V, PAPER	6353-4
C-2	50, 500V, CERAMIC	6361-15
C-3	50, 500V, CERAMIC	6361-15
C-4	0.01μF, 500V, CERAMIC DISC	6360-6
C-5	50, 500V, CERAMIC	6361-15
C-6	0.05μF, 600V, PAPER	6353-3
C-7	0.1μF, 400V, PAPER	6353-4
C-8	0.05μF, 600V, PAPER	6353-3
C-9	0.05μF, 600V, PAPER	6353-3
C-10	0.01μF, 300V, SILVER MICA	6359-41
C-11	25μF, 25V, ELECTROLYTIC	6355-4
C-12	1000, CERAMIC STAND OFF	2642
C-13	500, 500V, BUTTON	2641
C-14	5600, 500V, MICA	6359-38
C-15	0.5μF, 600V, BATHTUB	325
C-16	240, 500V, SILVER MICA	6359-15
C-17	5600, 500V, MICA	6359-38
C-18	NOT USED	
C-19	25μF, 25V, ELECTROLYTIC	6355-4
C-20	240, 500V, SILVER MICA	6359-15
C-21	2000, 500V, CERAMIC	6361-26
C-22	25μF, 25V, ELECTROLYTIC	6355-4
C-23	5600, 500V, MICA	6359-38
C-24	240, 500V, SILVER MICA	6359-15
C-25	0.01μF, 500V, CERAMIC DISC	6360-6
D-1	CRYSTAL DIODE 1N21B (WAVEGUIDE)	D1/30
D-2	CRYSTAL DIODE 1N23B (DETECTOR)	D2/302
F-1	FUSE, 3 AMP. 250V	245
	FUSE HOLDER ½ INCH	243
I-1	PILOT LAMP, BAYONET 6-8V	249
I-2	PILOT LAMP, BAYONET 6-8V	249
	PILOT LAMP HOLDER	248
	PILOT LAMP BRACKET	250
	CONNECTORS:	
J-1	TERMINAL ASSEMBLY	257
J-2	SO 239-3	205
J-3	SO 239-3	205
J-4	SO 239-3	205
J-5	SO 239-3	205
J-6	SO 239-3	205
J-7	SO 239-3	205
J-8	SO 239-3	205
J-9	UG-58/U (MODIFIED)	206
J-10	TERMINAL ASSEMBLY	257
M-1	METER, 0-200 MA	324
P-1 A-B-C	CONNECTOR, UG-107B/U	208

B. MEGA-MATCH PARTS LIST.

Circuit Symbol No.	Description	Kay Part No.
	CAPACITORS: (ALL CAPACITORS IN μμF UNLESS OTHERWISE INDICATED).	
C-1	0.1μF, 400V, PAPER	6353-4
C-2	50, 500V, CERAMIC	6361-15
C-3	50, 500V, CERAMIC	6361-15
C-4	0.01μF, 500V, CERAMIC DISC	6360-6
C-5	50, 500V, CERAMIC	6361-15
C-6	0.05μF, 600V, PAPER	6353-3
C-7	0.1μF, 400V, PAPER	6353-4
C-8	0.05μF, 600V, PAPER	6353-3
C-9	0.05μF, 600V, PAPER	6353-3
C-10	0.01μF, 300V, SILVER MICA	6359-41
C-11	25μF, 25V, ELECTROLYTIC	6355-4
C-12	1000, CERAMIC STAND OFF	2642
C-13	500, 500V, BUTTON	2641
C-14	5600, 500V, MICA	6359-38
C-15	0.5μF, 600V, BATHTUB	325
C-16	240, 500V, SILVER MICA	6359-15
C-17	5600, 500V, MICA	6359-38
C-18	NOT USED	
C-19	25μF, 25V, ELECTROLYTIC	6355-4
C-20	240, 500V, SILVER MICA	6359-15
C-21	2000, 500V, CERAMIC	6361-26
C-22	25μF, 25V, ELECTROLYTIC	6355-4
C-23	5600, 500V, MICA	6359-38
C-24	240, 500V, SILVER MICA	6359-15
C-25	0.01μF, 500V, CERAMIC DISC	6360-6
D-1	CRYSTAL DIODE 1N21B (WAVEGUIDE)	D1/30
D-2	CRYSTAL DIODE 1N23B (DETECTOR)	D2/302
F-1	FUSE, 3 AMP. 250V	245
	FUSE HOLDER ½ INCH	243
I-1	PILOT LAMP, BAYONET 6-8V	249
I-2	PILOT LAMP, BAYONET 6-8V	249
	PILOT LAMP HOLDER	248
	PILOT LAMP BRACKET	250
	CONNECTORS:	
J-1	TERMINAL ASSEMBLY	257
J-2	SO 239-3	205
J-3	SO 239-3	205
J-4	SO 239-3	205
J-5	SO 239-3	205
J-6	SO 239-3	205
J-7	SO 239-3	205
J-8	SO 239-3	205
J-9	UG-58/U (MODIFIED)	206
J-10	TERMINAL ASSEMBLY	257
M-1	METER, 0-200 MA	324
P-1 A-B-C	CONNECTOR, UG-107B/U	208



MECHANICAL DETAIL - COAXIAL BEAT NOTE DETECTOR

Figure 12,
Schematic KC-1304-F, Mega-Match.

Circuit Symbol No.	Description	Kay Part No.
	RESISTORS: (UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE.)	
R-1	1 MEG	1051-E
R-2	3.3 K	3321-E
R-3	1 MEG, 2W, VARIABLE COMPOSITION	130
R-4	330 K	3341-E
R-5	180 K	1841-E
R-6	33 K	3331-E
R-7	4.7 K	4721-E
R-8	220	2211-E
R-9	2.2 MEG	2251-E
R-10	1 MEG	1051-E
R-11	47 K	4731-E
R-12	47 K	4731-E
R-13	12 K	1231-E
R-14	33 K	3331-E
R-15	330 K	3341-E
R-16	150 K	1541-E
R-17	15 K	1531-E
R-18	330 K	3341-E
R-19	150 K	1541-E
R-20	25 K, 2W, VARIABLE COMPOSITION	713
R-21	500 K, 2W, VARIABLE COMPOSITION	126
R-22	430 K	4341-E
R-23	500 K, 2W, VARIABLE COMPOSITION	126
R-24	100 K, 2W, VARIABLE COMPOSITION	121
R-25	25 K, 2W, VARIABLE COMPOSITION	713
R-26	220 K	2241-E
R-27	1.5 MEG	1551-E
R-28	1 MEG	1051-E
R-29	180 K	1841-E
R-30	500 K, 2W, VARIABLE COMPOSITION	126
R-31	180 K	1841-E
R-32	2.2 K	2221-E
R-33	220	2211-E
R-34	CARBON RESISTANCE CARD	1638
R-35	CARBON RESISTANCE CARD	5668
R-36	10	1001-E
R-37	180 K	1841-E
R-38	100 K	1041-E
R-39	100 K	1041-E
R-40	2.7 K	2721-E
R-41	180 K	1811-E
R-42	100 K	1041-E
R-43	100 K	1041-E
R-44	1 K	1021-E
R-45	820	8211-E
R-46	600 K, 2W, VARIABLE COMPOSITION	129
R-47	180 K	1841-E
R-48	CARBON RESISTANCE CARD	59
R-49	CARBON RESISTANCE CARD	58
S-1	SWITCH SPST	255-C
S-2	SWITCH SPST	255-C
S-3	SWITCH DPDT MOMENTARY	256
V-1	TUBE, 2D21	2D21
V-2A	TUBE, 12AX7	12AX7
V-2B	NOT USED	
V-3	TUBE, 12AU7	12AU7
V-4	TUBE, 2K25/723A-B KLYSTRON	2K25/723AB
V-5	TUBE, 2K25/723A-B KLYSTRON	2K25/723AB
V-6	TUBE, 6J5	6J5
V-7	TUBE, 6SL7	6SL7
Z-1	CARBON RESISTANCE CARD	52
	WAVEGUIDE ASSEMBLY	30
	WAVEMETER ASSEMBLY	31S
	TERMINAL BLOCK	259
	DETECTOR ASSEMBLY	302

NOTES